MATCHING COAL STORAGE STANDARDS TO COMMUNITY NEEDS

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ABSTRACT

Coal is a basic energy resource for electricity generation providing the possibility of cheap and reliable electricity to enhance the quality of life of any community. Coal storage for such a power station is an insurance policy ensuring continuing supply of power to the community. A coal fired power station and its adjacent coal storage area provide a major contribution to fulfilling a critical community need.

Coal stockpiles are usually located adjacent to the power station they serve and are sized to provide adequate resource reserves to meet likely power needs. Competent design can ensure that their impact on the local community is minimal.

Coal has a number of properties that, if inadequate design prevails, may contribute to community dissatisfaction. The major factors of community concern are coal dustiness and noise in excess of the adjacent power station. Both of these can be controlled to match community needs at relatively low cost at the time the stockpile is being designed and at greater cost after construction.

1 INTRODUCTION

Energy is a modern necessity for any community. Once energy in the form of coal or oil is transformed into electricity the cost of storage is very high and the capacity to do so is extremely limited. Pumped storage reservoirs are the only viable solution at present for storing significant quantities of electrical power.

Storage before transformation into electricity is rather less expensive, no matter which energy resource is chosen. Oil requires an extensive tank farm, water requires large dams, gas requires pipeline capacity and coal requires space adjacent to the power station. All of this storage is an effective insurance policy providing continuity of supply of electricity. Where the energy resource is imported the need for effective storage is even more critical.

Because of the cost of storage a balance must be made between the cost of extra storage and the consequences of loss of supply. Long term reliable suppliers of energy resources, whether coal or other resource are an added requirement. Other factors such as cost of land also enter into the equation. Coal is one of the less expensive resources with respect to storage.

Storage technology may be quite different for domestic and international coal trade applications. For domestic delivered coal a simpler stockpile design, perhaps involving mechanical stacking out and rubber / track vehicle recovery, may be the most economical arrangement. International coal delivered from large and small ships generally requires a more complex and expensive stockpile. The stockpile, when operating provides an excellent source of energy for other industries locally.

2 COMMUNITY NEEDS

The primary community need in this context is a reliable continuous supply of cheap competitively priced electricity. An adequately sized stockpile of coal represents a major contribution to fulfil this need.

A secondary community need is for minimum environmental interference to their quality of life from the operation of such a stockpile. There are two significant factors that can be effectively minimized at relatively low cost in the overall expenditure for the stockpile.

The first of these is the question of coal dustiness. This is a function of local weather conditions and coal properties associated with fine particle size and moisture content.

The second is the level of noise arising from the coal stockpile above the other noises from the adjacent power station proper. This is more concerned with the design of the mechanical plant associated with delivering, handling and sending the coal to the power station.

In many cases the provision of a buffer zone around the periphery of the stockpile may be the cheapest and most effective solution to these and other problems.

3 COAL PROPERTIES CONCERNED WITH STORAGE

The coal properties of concern with respect to storage are discussed below in some detail. They may be subdivided into chemical properties and physical properties. Most of these properties are defined in the specification for the coal and standards exist to describe them.

3.1 Specific energy

The specific energy of the coal is a chemical property that dictates the amount of coal necessary to generate a specific amount of power. It is therefore critical in determining the extent of a coal storage area to give assurance of continuity of supply for a specified period.

A stockpile is required to hold a specific amount of energy that can be converted into tonnes of coal using the specific energy of the coal. This tonnage can be converted into a volume from knowledge of the density of the coal. This can be redefined as an area from knowledge of the type of stockpile envisaged.

3.2 Density

Coal density is a physical property allowing estimation of the volume of coal required to provide a specified level of energy reserve.

3.3 Mineral matter

Coal contains a significant proportion of mineral matter. This is minimized in international export coal because of the cost of transport of non-combustible material over long distances. Some of the minerals have the potential to be leached from the coal leading to leachate with undesirable chemical properties. The effect of this can be minimized by the use of drainage ditches around the stockpile together with storage reservoirs for settling smaller coal particles.

3.4 Moisture

The moisture content of coal is required to determine if additional water sprays are needed, while being stored, as a function of local wind velocities at the stockpile. Standard tests allow the level of dustiness of a particular coal with a specific moisture content and standard wind load to be determined.

Additional water can be added if required, in the form of sprays, to the surface of the stockpile.

3.5 Particle size distribution

The particle size distribution of coal stored in a stockpile is critical for a number of reasons. Coal is supplied to the stockpile as a range of particles from about 50 mm down to less than 10 microns, adhering to the larger particles. This is a result of the previous preparation treatment of the coal prior to delivery. The performance of crushing equipment and subsequent classification dictates the top size and size distribution.

The storage of larger particles is preferred when there are monsoons or possible heavy rain to minimize runoff and the possibility of leaching soluble minerals. However this must be balanced against the proportion of coal less than about 100 microns that does not need to be ground further to provide effective burnout in a pulverized coal fired furnace. This coal is subject to greater runoff potential.

3.5.1 Top size

There is a limit to the top size of coal for power stations. This is dictated by the upper limits of acceptable coal for the pulverizers. Internationally traded coal has a top size of about 50 mm. Some pulverizers cannot accept material with a greater particle diameter.

3.5.2 Fines

In a similar manner internationally traded coals have a specified fines content of material less than 1 mm in diameter. This prevents or minimizes the likelihood of dust release with high wind velocity. The release of particles is a function of size and moisture content.

3.6 Flow properties and segregation

Standards exist for measuring the flow of coal particle through bins and chutes. Knowing the flow properties of the coal enables the design of bins and chutes so that the design coal can flow freely. If the free flow of coal is affected, leading to equipment shutdown there is a greater possibility that dust will be released locally.

Segregation of different diameter particles and re-mixing occurs at every transfer point in the coal handling system. At these points there is the possibility that fines will be preferentially ejected from the flowing material and cause some dust haze. Good housekeeping is necessary to minimize these effects.

3.7 Dustiness

There are standards defining dustiness of coal with different moisture contents.
The particle size distribution of coal on the stockpile is critical if the stockpile is dry and there are appreciable winds. For coal with a high proportion of fines these can become a community nuisance in high winds.

The dustiness can be controlled by spraying with water to increase the surface moisture near the outer layer of the pile. Normally there are wind speed indicators that trigger water sprays when the surface of the stockpile dries out and there is a wind speed above a critical minimum.

Other measures such as wind barriers around the perimeter of the stockpile may be helpful.

3.8 Spontaneous combustion

A combination of the reactivity of the particular coal and the manner of storage allowing moisture and air access with consequent slow reaction and local heating can result in stockpile fires. Tests are available to determine the likelihood of this phenomenon. Usually good housekeeping with respect to the storage area and movement of stock that is showing signs of heating will keep this under control.

4 COAL STORAGE TECHNOLOGY

Coal storage technology is concerned with transport, storage and processing the coal for the power station. Coal is transported, stored, classified and blended on the one stockpile site. Each of these operations has different environmental implications.

There is a strong need at the design stage to decide on the necessary attributes of stockpile and design for this rather than try to use stockpile for duty for which it was not designed. For instance a stockpile not designed for blending may have considerable problems if blending becomes necessary and provide community problems in so doing.

Storage technology may be divided into a number of different categories. The main classification lies in the machinery to stack out and recover coal.

4.1 Fixed machinery

In this case large stacker reclaimers are used to deliver and recover coal. The coal is laid out in long parallel heaps with stacker / reclaimers operating on rail lines between the heaps. Simple machinery results in long heaps with undesirable blending and segregation problems. More sophisticated machinery with more complex controls results in coal in a well blended condition and less tendency to dustiness or spontaneous combustion. The major types of system are set out below.

4.1.1 Longitudinal stockpile

4.1.1.1 Chevron system

In this method each successive pass of the stacker moves along the spine of the heap and produces a series of larger triangular sections. Larger particles segregate to the outer lower region of the heap.

Recovery is usually by horizontal slice. This procedure promotes dust emission and particle segregation in return for a significantly simpler stacker control system. It also increases the likelihood of spontaneous combustion.

4.1.1.2 Windrow system

Here successive passes of the stacker move along the spine leading to a number of heaps of equal height. The following passes fill in the gaps. This does not suffer too much from large lump segregation.

Recovery is usually by horizontal slice. This is the preferred system resulting in reduced dust emission and less segregation. It involves a more complex stacker control system.

4.1.1.3 Layered system

This system has the stacker moving sideways about the spine of the stockpile to lay down successive flat horizontal layers. It suffers from very little segregation but requires a more complex stacker unit.

Recovery is usually not by horizontal slice technique for obvious reasons.

4.1.1.4 Cone-ply system

In this system a first stacker pass occurs off-centre of the stockpile spine. Successive passes index the discharge point closer to the spine. This results in significant size segregation.

Recovery can be by horizontal slice.

4.1.1.5 Axial system

This is essentially the reverse of the previous system where a small off-centre triangular section is stacked out, followed by indexed layers with the discharge head of the stacker reclaimer moving nearer the spine of the stockpile at each pass. It too suffers from large particle segregation and recovery is normally by horizontal slice.

4.1.2 Circular stockpile

Circular stockpiles are less frequent and chevron type stacking systems are common.

4.2 Mobile machinery

It is possible to operate a stockpile using rubber tyred or bulldozer equipment to recover coal with stacking out from overhead conveyors. The possibilities for dust release are increased by the height of the conveyor system.

This is generally a lower capital cost installation but suffers from difficulty in effective blending if this is necessary.

5 ISSUES IN COAL STORAGE

5.1 Extent of stockpile

The capacity of the adjacent power station, reliability of ship or other delivery method and supply to other local industries controls the extent of any specific stockpile.

Most stockpiles are divided into active and passive storage areas. Active areas are used to deliver and recover coal for day-to-day use. In many cases, particularly for poor weather conditions this area of the stockpile may be covered to minimize effects of heavy rain.

Passive areas are normally laid down, consolidated and left as a reserve against failure of the ship or other delivery system.

5.2 Weather

Heavy rain and monsoon conditions require considerable attention in stockpile design. Coal is a valuable product and losses from runoff need to be minimized. Runoff also may cause discharge into surrounding areas or waterways.

Usually a stockpile is surrounded by a ditch system leading runoff water and any suspended solids into a retaining reservoir where coal fines can be recovered by bulldozer and returned to the stockpile. Water treatment may be necessary before runoff is allowed into the nearest waterway, particularly if there are minerals present that can leach out of the coal with heavy rain.

5.3 Stockpile leachate

Some coals contain soluble mineral matter that can leach from the coal with heavy rain.

5.4 Spontaneous combustion

Some coals are more likely than others to spontaneously combust. These can be identified and appropriate storage techniques used to prevent this happening. Generally movement within a definite time frame is adequate treatment to minimize the chance of spontaneous combustion.

Spontaneous combustion usually occurs about two thirds of the way down the sloping face of the coal in a longitudinal stockpile. At this point particle segregation has resulted in larger particles flowing down the face and allowing air with oxygen to penetrate into the coal face. Oxygen from the air and moisture combine to increase the local material temperature to the point where combustion takes place.

If particular coals have spontaneous combustion tendencies this may be controlled by moving the coal within fixed time periods. The stockpile takes a significant time for local temperatures to increase to the point of combustion and movement breaks this temperature increase cycle.

Matching coal storage standards to community needs

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Community needs

- Reliable continuous supply of competitive cheap electricity
- Minimum environmental interference to quality of life

Energy storage

- Electricity storage
- Energy resource storage, gas, oil, coal, nuclear, water
- Storage is an insurance for continuity of supply of power

Coal properties and storage

- Specific energy
- Density
- Mineral matter
- Moisture
- Particle size
- Flow properties
- dustiness

Specific energy

- Power stations need energy input
- Specific energy enables this to be expressed in tonnes of coal

Coal density

- Quantity of coal can be expressed as a volume using coal density
- Coal volume can be used to define the area and shape of a potential stockpile

Mineral matter

- Most mineral matter is insoluble and therefore inert on a stockpile
- Some mineral matter is soluble and may lead to leachate requiring attention

Moisture

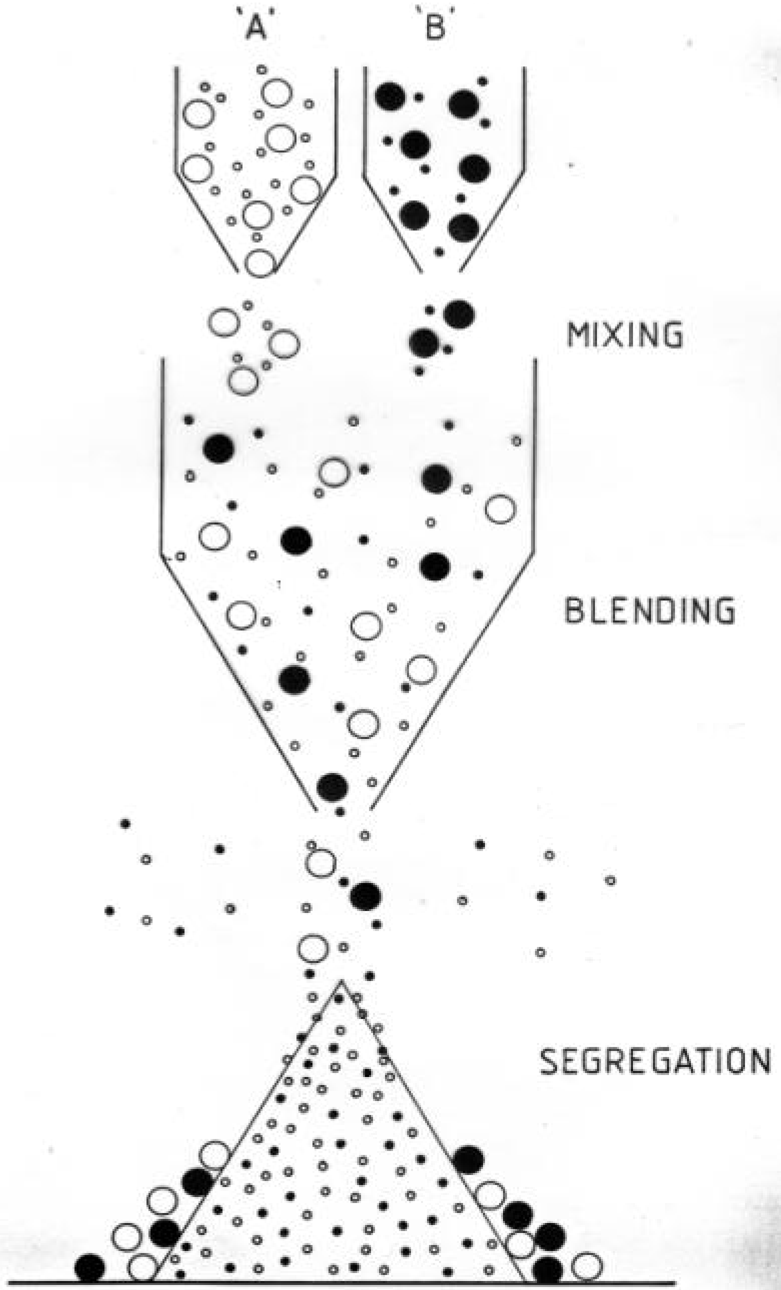
- There is a relationship between moisture and particle size distribution minimizing dustiness
- Monsoon weather may result in excessive runoff and possible leachate

Particle size

- Top size, defined by international coal specifications, capable of being pulverized by conventional mills.
- Fines, defined by international coal specifications, source of dustiness unless moisture is controlled

Flow properties

- Standards for measurement and design of appropriate bins exist
- Failure to design and measure may result in many blockages and consequential dustiness



'A'
'B'
MIXING
BLENDING
SEGREGATION

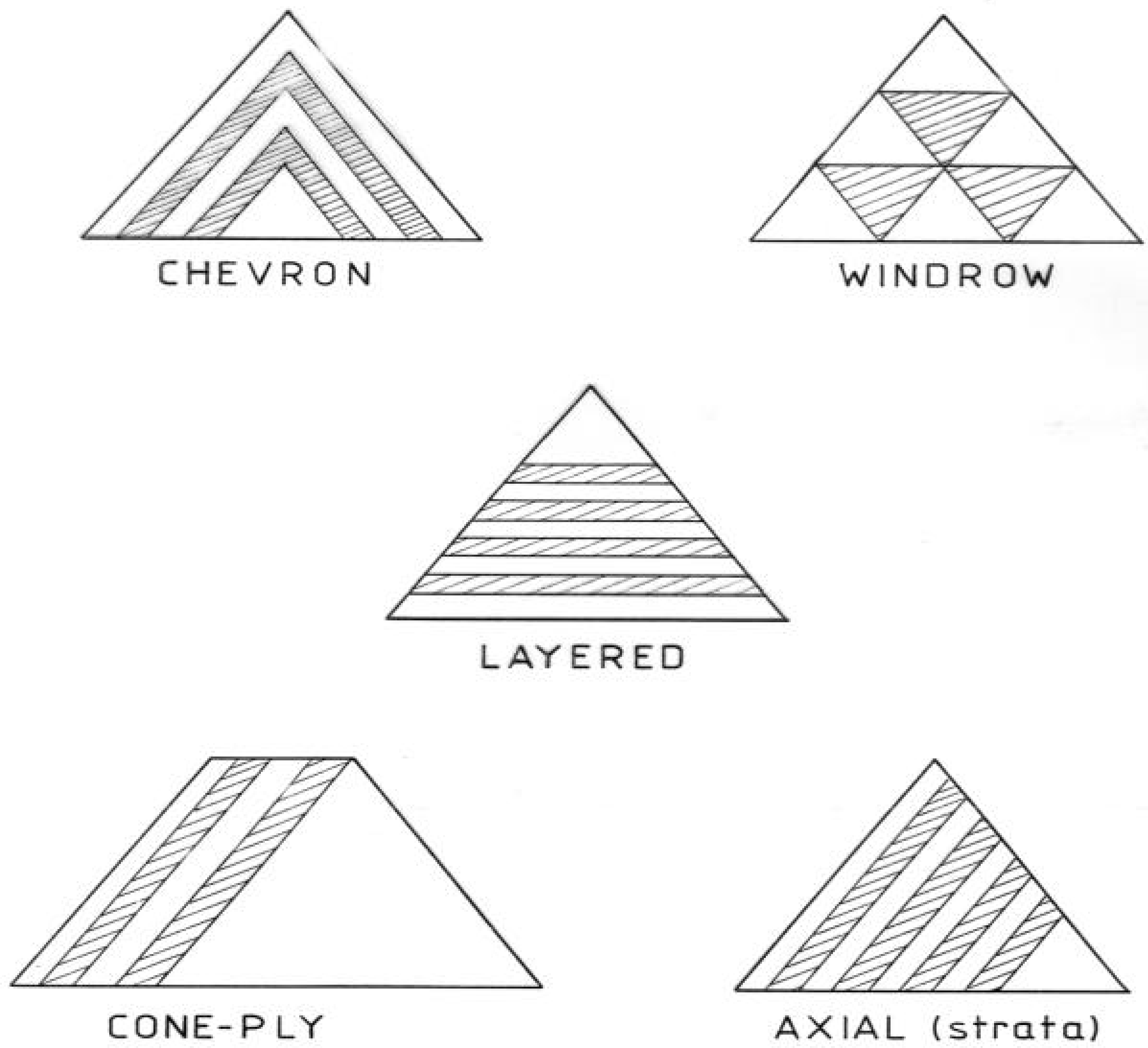
Dustiness

- Standards exist for measuring the dustiness of coal with varying moisture content.
- Control stockpile dustiness using minimum necessary water sprays for existing weather, especially wind velocity

Storage technology

- Fixed stacker reclaimer machinery
- longitudinal stockpiles
- circular stockpiles

- Mobile machinery



LONGITUDINAL STOCKPILE

Issues in coal storage

- Extent of stockpile
- Weather
- Stockpile leachate
- Spontaneous combustion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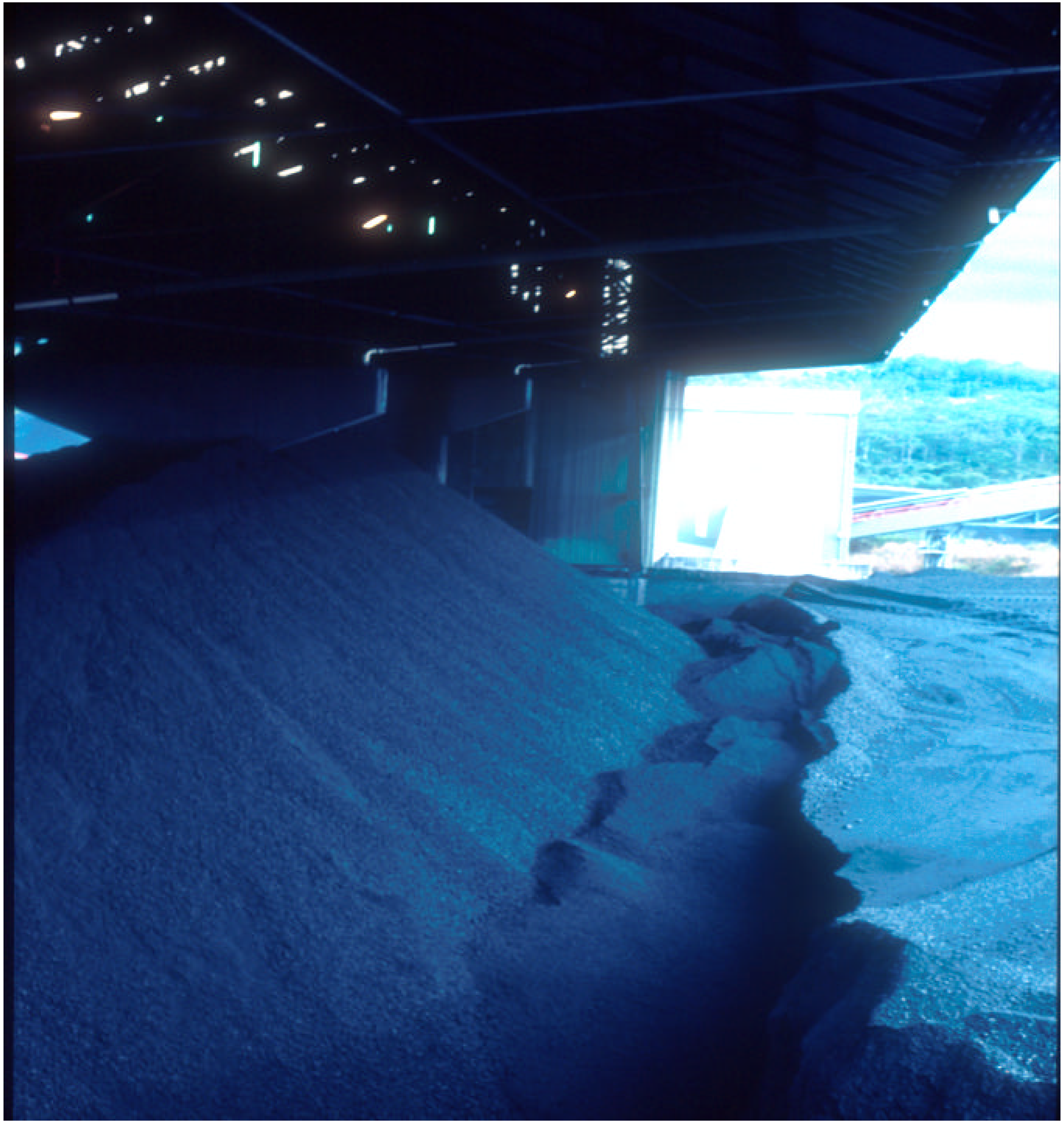

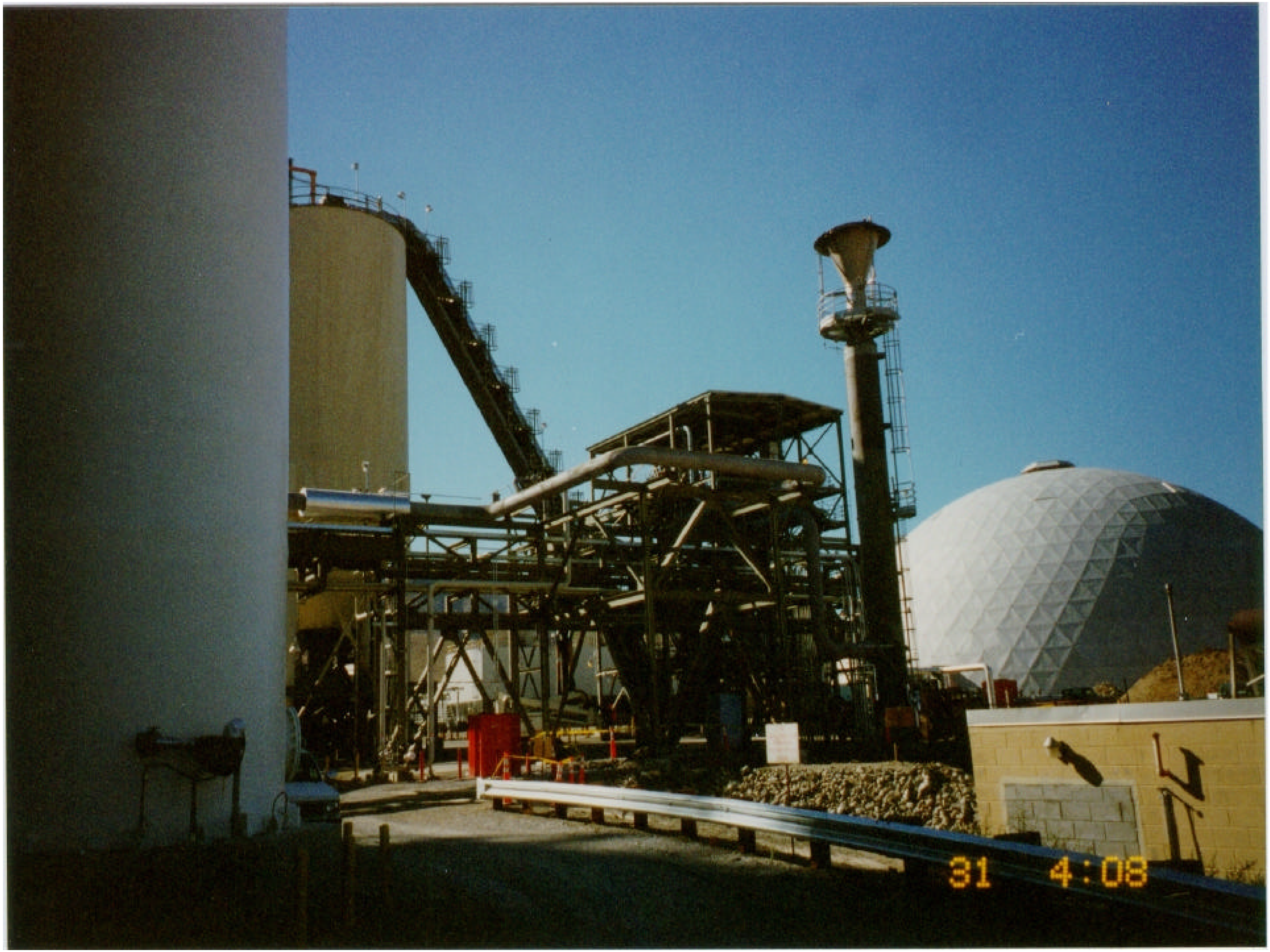
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